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(54) **CONTEXT AND ENVIRONMENT AWARE VOLUME CONTROL IN TELEPHONIC CONVERSATION**

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| ***H04M 1/60*** | (2006.01) |
| ***H04M 15/00*** | (2006.01) |
| ***H04W 4/02*** | (2009.01) |

(52) **U.S. Cl.**
CPC ..... ***H04M 1/72569*** (2013.01); ***H04M 1/6033*** (2013.01); ***H04M 1/72572*** (2013.01); ***H04M 15/8033*** (2013.01); ***H04W 4/021*** (2013.01)

(58) **Field of Classification Search**
CPC ..... H04M 1/72569; H04M 1/72572; H04M 1/6033; H04M 15/8033; H04W 4/021
See application file for complete search history.

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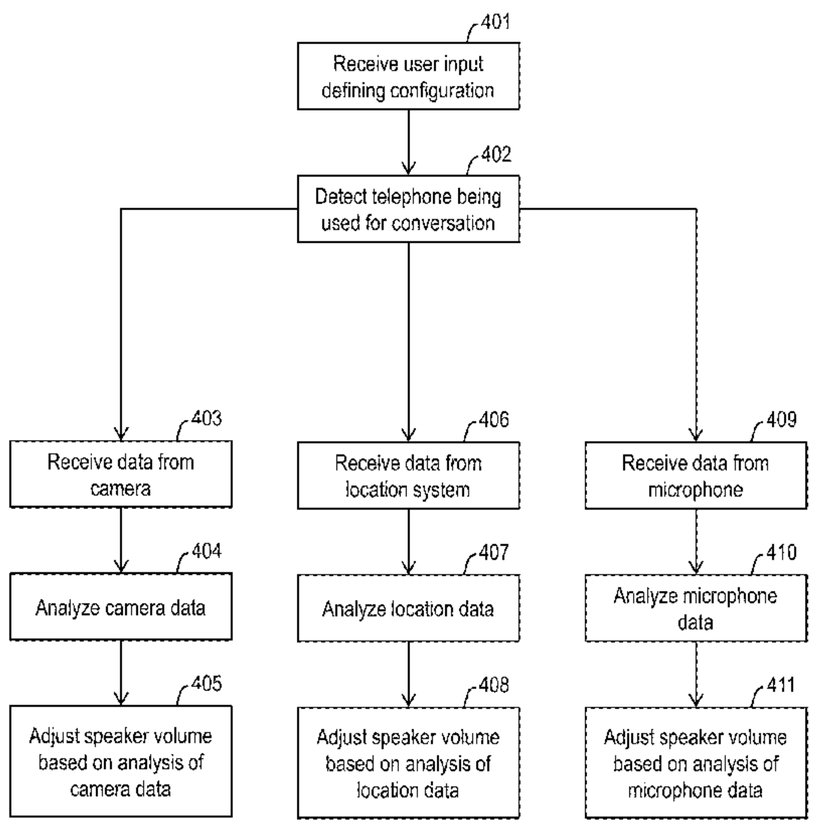
(57) **ABSTRACT**

Systems and methods for automatically adjusting telephonic conversation volume are provided. A computer-implemented method includes: detecting a telephone being used for a conversation and receiving data from at least one of a microphone, a camera, and a location system associated with the telephone. The method includes analyzing the data to determine at least one of: usage of sensitive or confidential words in the conversation; distance of the telephone to another person; level of annoyance of another person; conversation loudness relative to ambient loudness; location of the telephone relative to quiet areas. The method includes automatically adjusting a volume of a speaker of the telephone during the conversation based on the analyzing.

**14 Claims, 5 Drawing Sheets**



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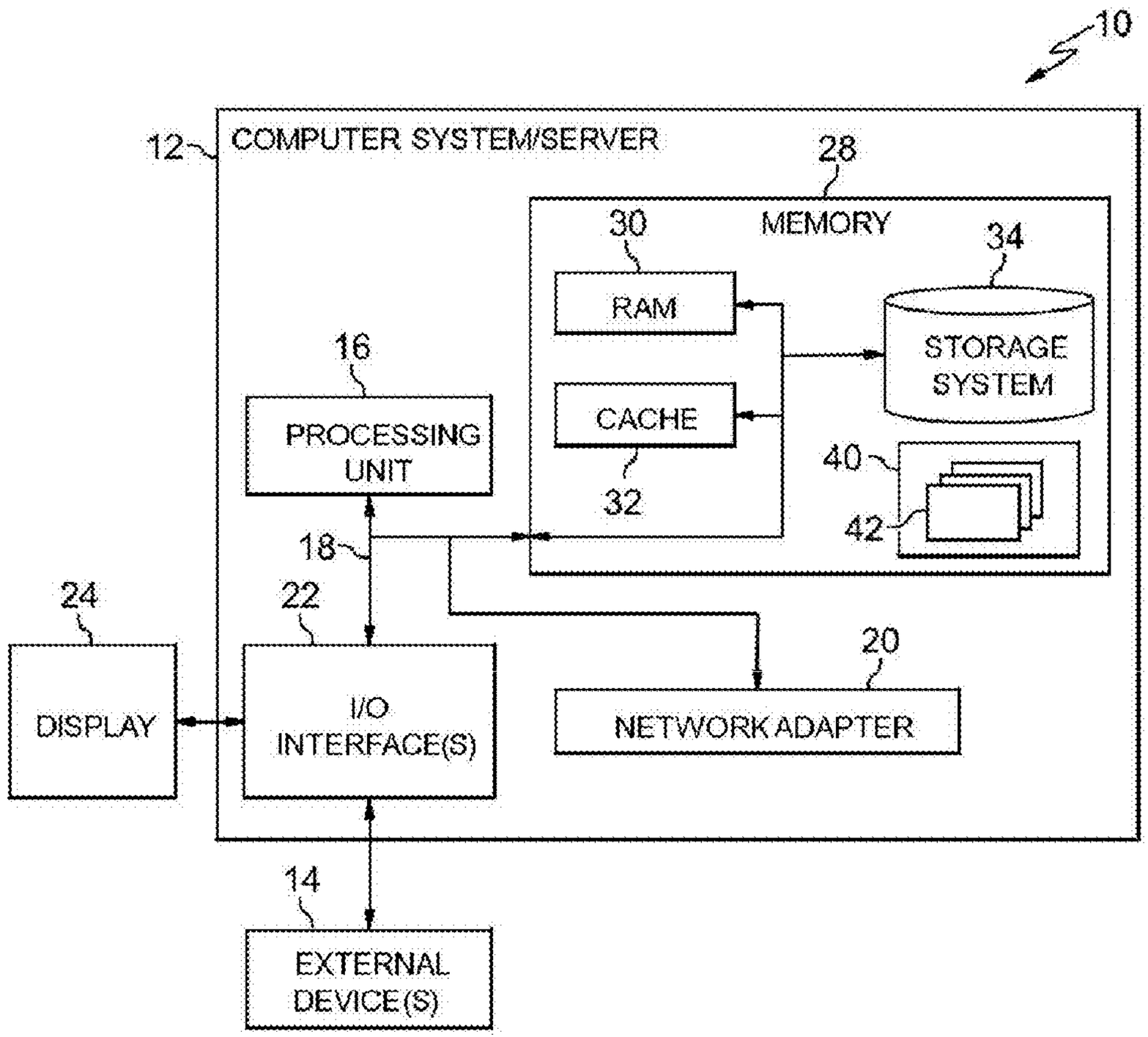
10
12
COMPUTER SYSTEM/SERVER
28
MEMORY
30
RAM
34
STORAGE SYSTEM
16
PROCESSING UNIT
CACHE
32
40
42
18
24
22
20
DISPLAY
I/O INTERFACE(S)
NETWORK ADAPTER
14
EXTERNAL DEVICE(S)

FIG. 1

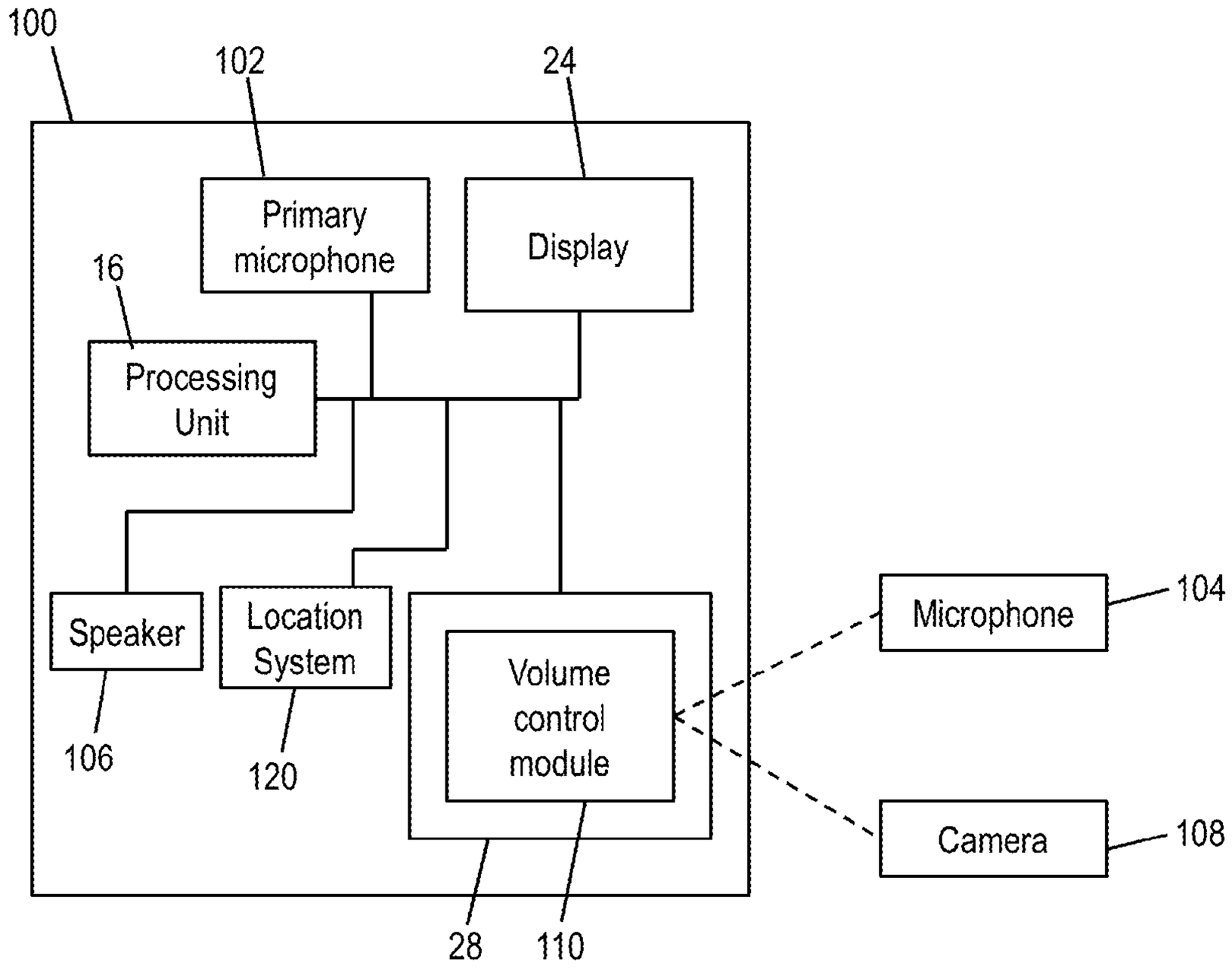
100
102
24
Primary microphone
Display
16
Processing Unit
Speaker
Location System
Volume control module
Microphone
104
106
120
Camera
108
28
110

FIG. 2

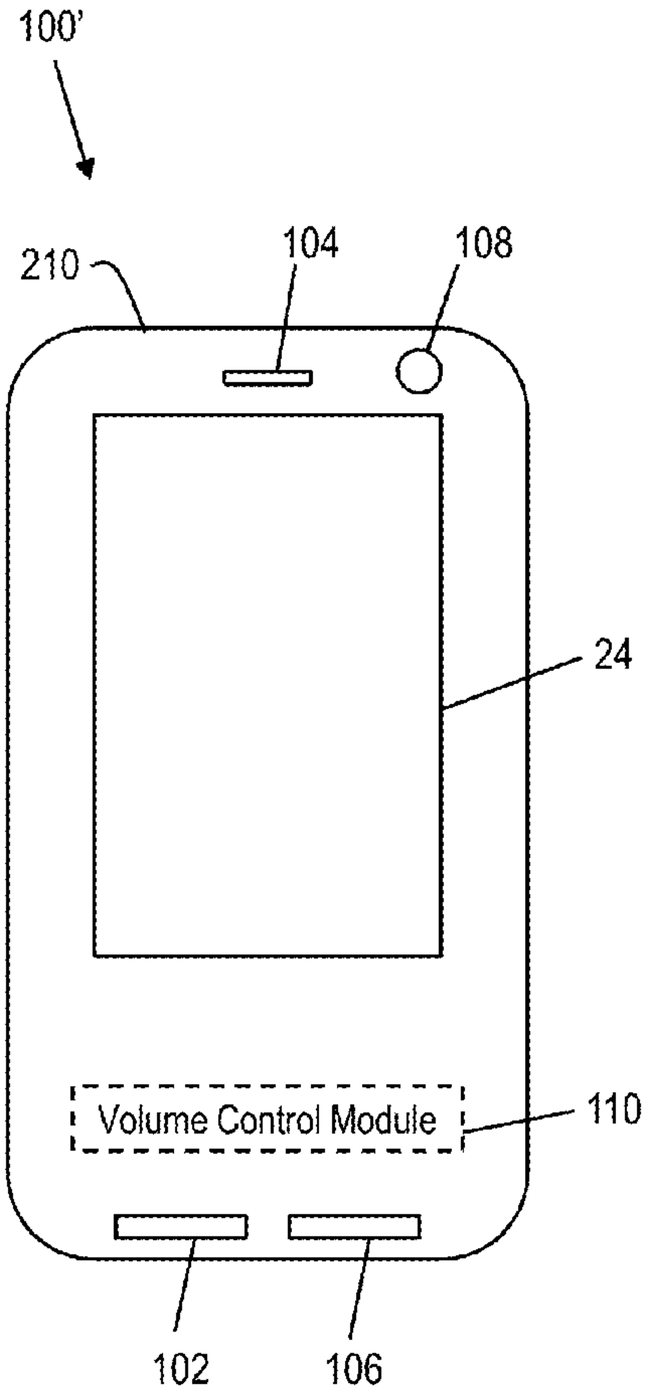
100'
210
104
108
24
Volume Control Module
110
102
106

FIG. 3A

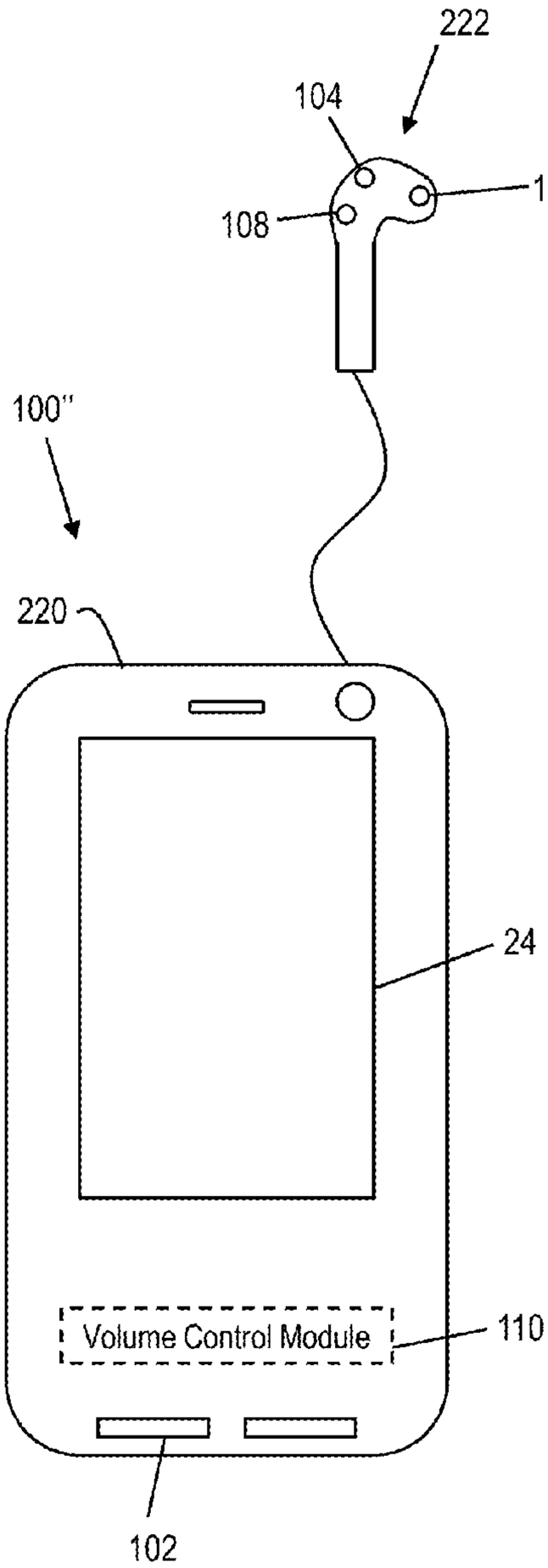
222
104
106
108
100''
220
24
Volume Control Module
110
102

FIG. 3B

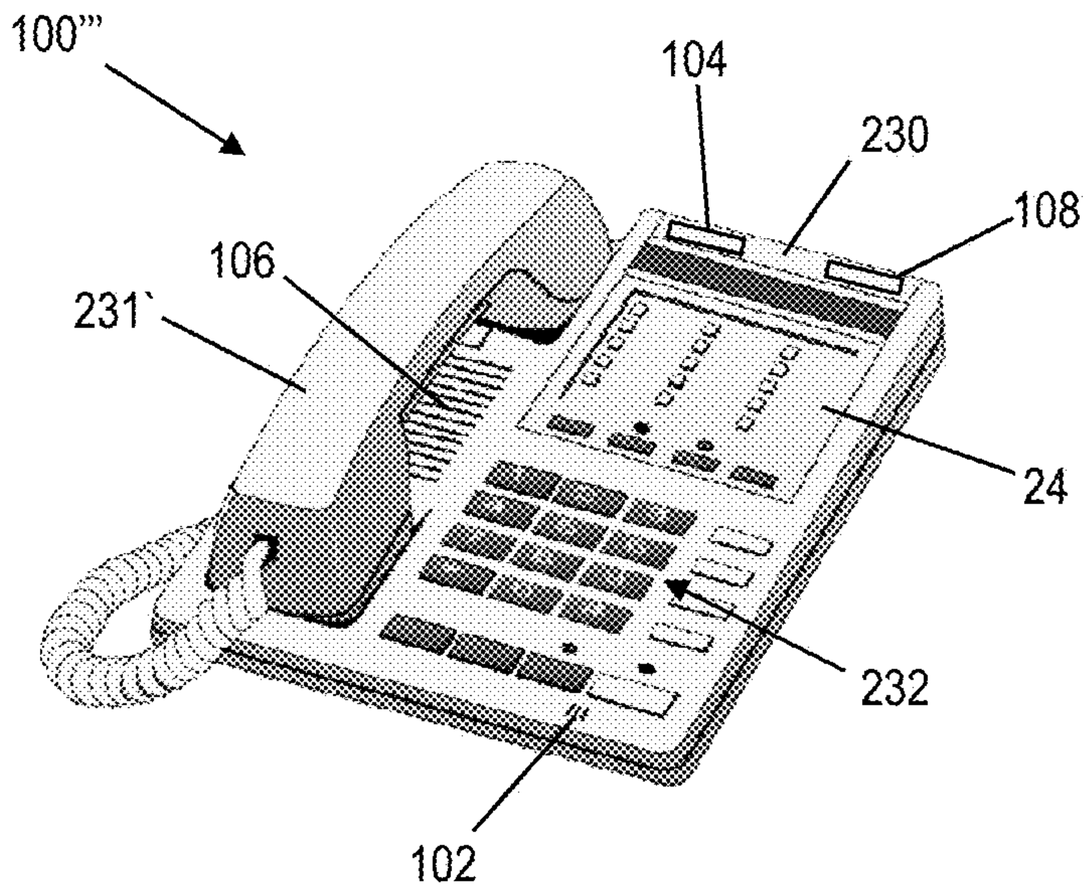
100'''
104
230
108
106
231`
24
232
102

FIG. 3C

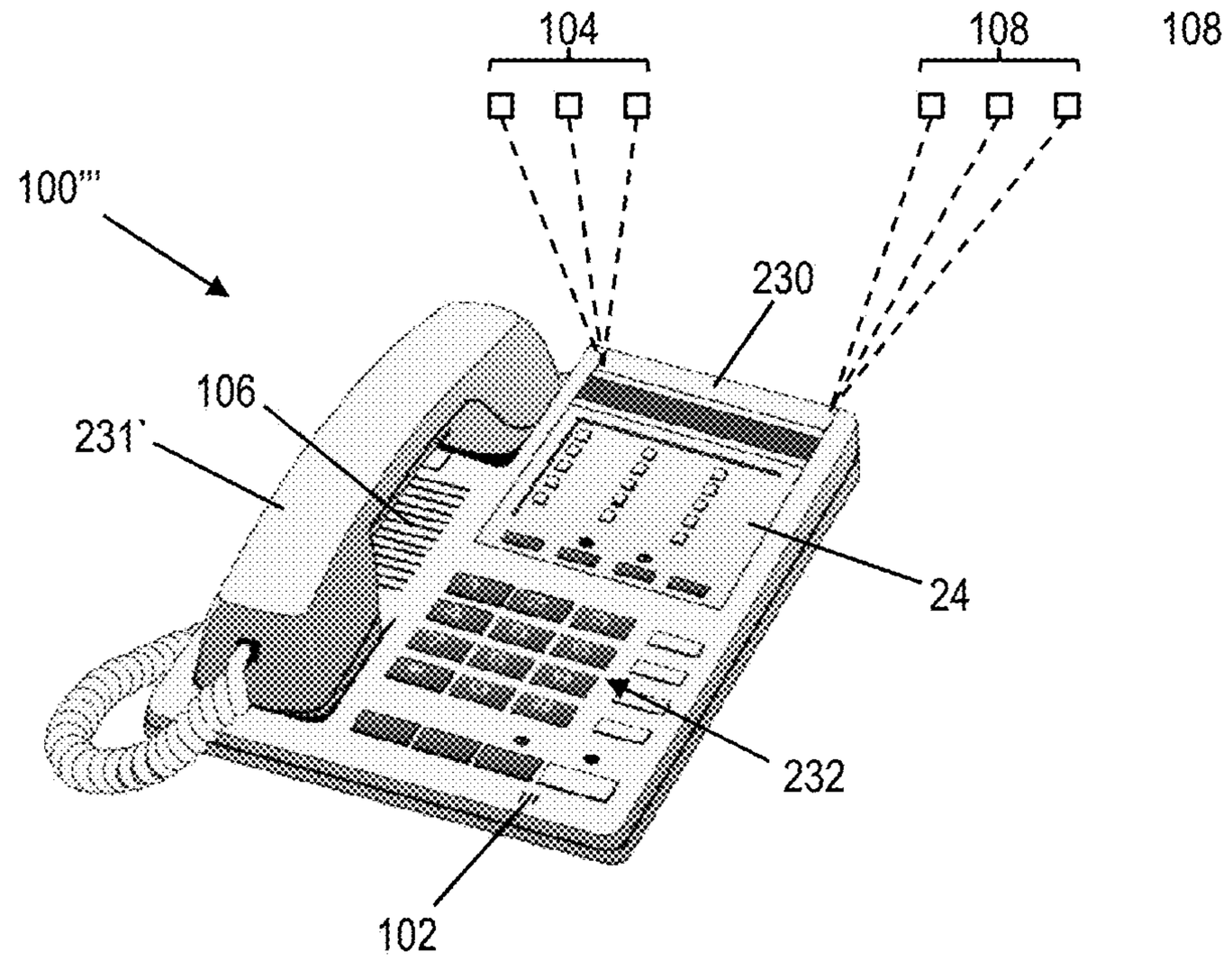
104
108
108
100'''
230
106
231`
24
232
102

FIG. 3D

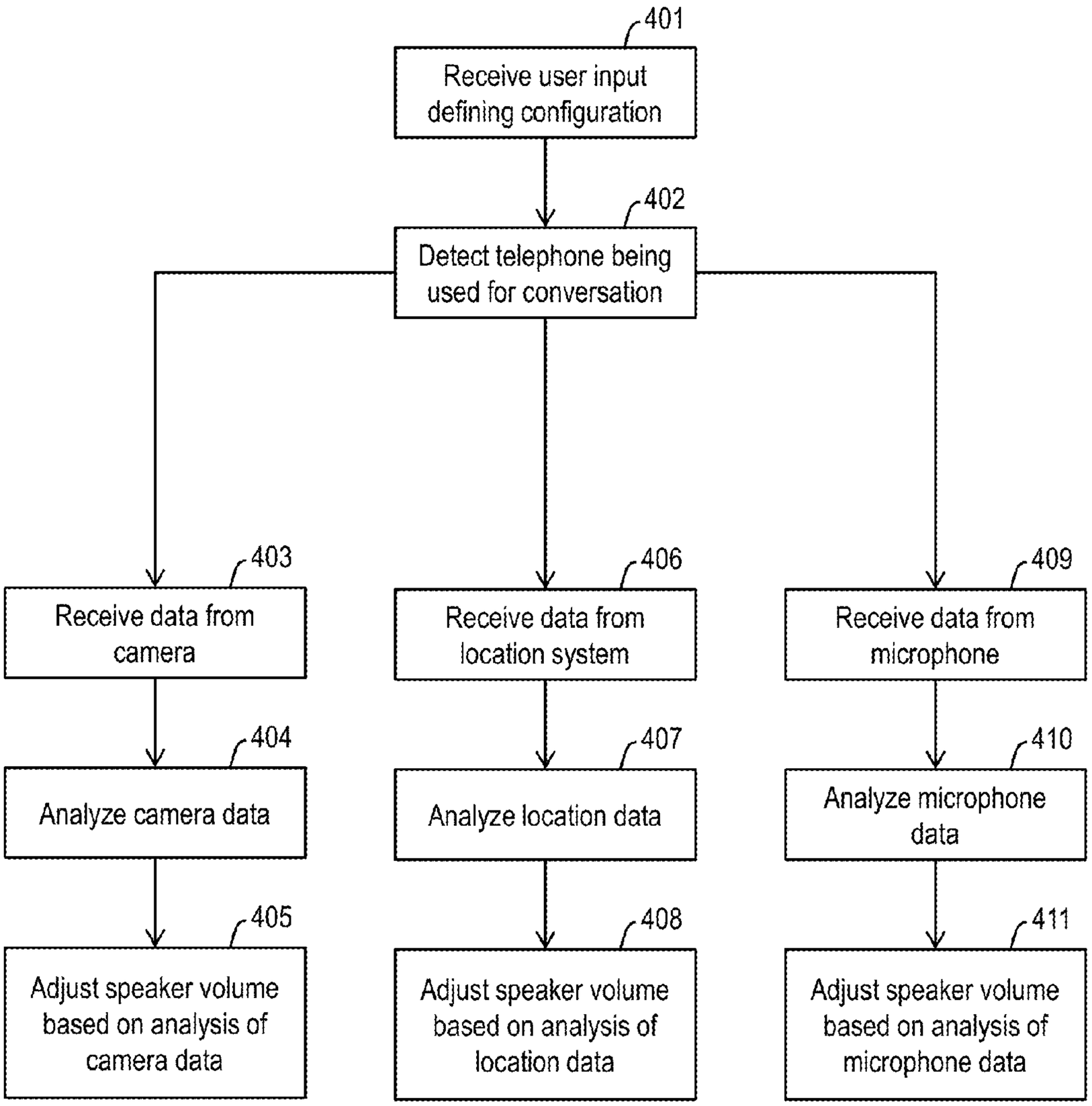
401
Receive user input defining configuration
402
Detect telephone being used for conversation
403
Receive data from camera
404
Analyze camera data
405
Adjust speaker volume based on analysis of camera data
406
Receive data from location system
407
Analyze location data
408
Adjust speaker volume based on analysis of location data
409
Receive data from microphone
410
Analyze microphone data
411
Adjust speaker volume based on analysis of microphone data

FIG. 4

# CONTEXT AND ENVIRONMENT AWARE VOLUME CONTROL IN TELEPHONIC CONVERSATION

## BACKGROUND

The present invention relates generally to telephone devices and, more particularly, to automatic volume control in telephone devices.

Telephone usage has become nearly ubiquitous in modern life. A problem with telephone usage in crowded spaces is that often a telephone conversation by one person can be heard by other people in the vicinity. People often set the volume to a high level on their telephone device with the result that other people in the vicinity of the telephone can hear one or both sides of the conversation. This can be annoying to the people that are subjected to someone else's conversation. It can also be embarrassing and/or damaging to the person conducting the conversation, for example, when sensitive or confidential subject matter is unintentionally revealed to other people in the vicinity.

## SUMMARY

In an aspect of the invention, a computer implemented method includes detecting a telephone being used for a conversation and receiving data from at least one of a microphone, a camera, and a location system associated with the telephone. The method includes analyzing the data to determine at least one of: usage of sensitive or confidential words in the conversation; distance of the telephone to another person; level of annoyance of another person; conversation loudness relative to ambient loudness; location of the telephone relative to quiet areas. The method includes automatically adjusting a volume of a speaker of the telephone during the conversation based on the analyzing.

In another aspect of the invention, there is a system for automatically adjusting telephonic conversation volume. The system includes: a telephone comprising a processor running a volume control module; at least one microphone configured to provide microphone data to the volume control module; at least one camera configured to provide camera data to the volume control module; and a location system configured to provide location data to the volume control module. The volume control module is configured to automatically reduce a volume of a speaker of the telephone during a conversation based on analyzing at least one of the microphone data, the camera data, and the location data.

In another aspect of the invention, there is a computer program product for automatically adjusting telephonic conversation volume. The computer program product includes a computer readable storage medium having program instructions embodied therewith. The program instructions are executable by a computing device to cause the computing device to: detect a telephone being used for a conversation; obtain microphone data, camera data, and location data associated with the telephone; determine, using the microphone data, whether sensitive or confidential words are used in the conversation using natural language processing; determine, using the microphone data, whether conversation loudness exceeds ambient loudness by a predefined amount; determine, using the camera data, whether another person is within a predefined distance of the telephone; determine, using the camera data, a level of annoyance of another person; determine, using the location data, whether a location of the telephone coincides with a predefined quiet area; and automatically adjust a volume of a speaker of the telephone based on at least one of the microphone data, the camera data, and the location data.



## BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is described in the detailed description which follows, in reference to the noted plurality of drawings by way of non-limiting examples of exemplary embodiments of the present invention.

FIG. **1** depicts a computing infrastructure according to an embodiment of the present invention.

FIG. **2** shows an exemplary environment in accordance with aspects of the invention.

FIGS. **3**A-**3**D show exemplary implementations in accordance with aspects of the invention.

FIG. **4** shows a flowchart of a method in accordance with aspects of the invention.

## DETAILED DESCRIPTION

The present invention relates generally to telephone devices and, more particularly, to automatic volume control in telephone devices. According to aspects of the invention, speaker volume on a device such as a phone is automatically adjusted based on a number of factors such as location, ambient sound levels, proximity to other people, detected level of annoyance of other people, and detected sensitive and/or confidential subject matter in the conversation. The factors may be determined based on data collected from sensors including at least one of: an audio capturing device (e.g., a microphone) that detects loudness of the telephone conversation; at least one camera that detects a person in the vicinity of the telephone; and a location system that determines a location of the telephone. The telephone may analyze data from the sensors using at least one of rules, image processing, and natural language processing to automatically reduce the audio volume of the telephone speaker.

Implementations of the invention provide a system and method to automatically understood the surroundings of a telephonic conversation and warn and user or automatically adjust a loudness level of the conversation. In embodiments, the automatic check of the surrounding area checks for location information such as whether this is a quiet place (e.g., library, school, business). In embodiments, the automatic check of the surrounding area checks for body language of others to determine whether others are being bothered. In embodiments, the automatic check of the surrounding area checks the level of surrounding ambient sound in order to determine if the conversational volume of the call is appropriate.

In an aspect of the invention, the volume of a telephone loudspeaker (e.g., speaker) is automatically controlled based on the conversation subject matter and whether it is determined to be sensitive or confidential. In embodiments, Natural Language Processing (NLP) is used to determine when the subject matter being discussed in a telephone call is sensitive or confidential, in which case the telephone being used in the conversation automatically reduces its speaker volume.

In another aspect of the invention, the volume of a telephone speaker is automatically controlled based on a determined distance of the telephone to another person. In embodiments, when a telephone is being used in a conversation, data collected by a camera associated with the telephone may be used to determine when another person is within a predefined distance relative to the telephone, in which case the telephone automatically reduces its speaker

volume. For example, image processing may be used to determine when a person is within the field of view of the camera associated with the telephone. Image processing may also be used to determine a distance from the camera to an object (e.g., the person) within the field of view of the camera. In this manner, a camera and image processing programs may be used to determine when another person is within a certain distance of the telephone, and the speaker volume of the telephone may be automatically adjusted based on this determination.

In another aspect of the invention, the volume of a telephone speaker is automatically controlled based on a determined level of annoyance of another person in the vicinity of the telephone. In embodiments, when a telephone is being used in a conversation, data collected by a camera associated with the telephone may be used to determine when a person within the vicinity of the telephone has reached a level of annoyance, in which case the telephone automatically reduces its speaker volume. The level of annoyance may be determined from body language such as facial expressions. For example, facial recognition programming may be used with the camera data to determine when a person within the field of view of the camera has reached a level of annoyance, e.g., by determining that their detected mood has changed from a first mood (e.g., happy, indifferent, etc.) to a second mood (e.g., anger, contempt, etc.).

In another aspect of the invention, the volume of a telephone speaker is automatically controlled based on a determined location of the telephone. The location of the telephone being used in a conversation may be determined using a location system such as a Global Positioning System (GPS). In embodiments, the determined location of the telephone is compared to pre-defined quiet areas, such as libraries, office areas, etc. In the event the location of the telephone is determined to be within a pre-defined quiet area, the telephone being used in the conversation automatically reduces its speaker volume.

In another aspect of the invention, the volume of a telephone speaker is automatically controlled based on a determined loudness relative to ambient sound levels. In embodiments, at least one microphone detects a loudness of the speaker of the telephone being used in a conversation and an ambient loudness of the surroundings. When the loudness of the telephone speaker exceeds the ambient loudness by a predefined amount (e.g., percentage or raw decibels), the telephone being used in the conversation automatically reduces its speaker volume.

Systems in accordance with aspects of the invention may be adapted to permit a user to configure features described herein. In embodiments, the system permits a user to selectively activate and deactivate automatic volume reduction for each of factors independent of the other factors. For example, a user may configure their telephone to activate automatic volume reduction as described herein for detected sensitive/confidential material and detected level of annoyance, but not to activate automatic volume for determined distance, determined location of the telephone, and determined loudness relative to ambient sound levels.

Another configurable feature may involve the telephone providing an alert to the user. For example, the user may be permitted to select one of the following modes of operation: the telephone provides an alert to the user without automatically reducing volume; the telephone provides an alert to the user and then automatically reduces volume a number of seconds after the alert; the telephone automatically reduces volume without providing an alert to the user.

Another configurable feature may involve the speed at which the telephone automatically reduces the volume. For example, the user may be permitted to select a period of time over which the volume reduction takes place, e.g., from zero seconds (an instantaneous reduction) to a non-zero number of seconds (a slower, fading reduction).

Aspects of the invention may be implemented with either: a landline telephone that is connected by a pair of wires to a telephone network; or a mobile phone, such as a cellular phone, that is portable and communicates with the telephone network by radio transmissions.

The present invention may be a system, a method, and/or a computer program product. The computer program product may include a computer readable storage medium (or media) having computer readable program instructions thereon for causing a processor to carry out aspects of the present invention.

The computer readable storage medium can be a tangible device that can retain and store instructions for use by an instruction execution device. The computer readable storage medium may be, for example, but is not limited to, an electronic storage device, a magnetic storage device, an optical storage device, an electromagnetic storage device, a semiconductor storage device, or any suitable combination of the foregoing. A non-exhaustive list of more specific examples of the computer readable storage medium includes the following: a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), a static random access memory (SRAM), a portable compact disc read-only memory (CD-ROM), a digital versatile disk (DVD), a memory stick, a floppy disk, a mechanically encoded device such as punch-cards or raised structures in a groove having instructions recorded thereon, and any suitable combination of the foregoing. A computer readable storage medium, as used herein, is not to be construed as being transitory signals per se, such as radio waves or other freely propagating electromagnetic waves, electromagnetic waves propagating through a waveguide or other transmission media (e.g., light pulses passing through a fiber-optic cable), or electrical signals transmitted through a wire.

Computer readable program instructions described herein can be downloaded to respective computing/processing devices from a computer readable storage medium or to an external computer or external storage device via a network, for example, the Internet, a local area network, a wide area network and/or a wireless network. The network may comprise copper transmission cables, optical transmission fibers, wireless transmission, routers, firewalls, switches, gateway computers and/or edge servers. A network adapter card or network interface in each computing/processing device receives computer readable program instructions from the network and forwards the computer readable program instructions for storage in a computer readable storage medium within the respective computing/processing device.

Computer readable program instructions for carrying out operations of the present invention may be assembler instructions, instruction-set-architecture (ISA) instructions, machine instructions, machine dependent instructions, microcode, firmware instructions, state-setting data, or either source code or object code written in any combination of one or more programming languages, including an object oriented programming language such as Smalltalk, C++ or the like, and conventional procedural programming languages, such as the "C" programming language or similar programming languages. The computer readable program

instructions may execute entirely on the user's computer, partly on the user's computer, as a stand-alone software package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server. In the latter scenario, the remote computer may be connected to the user's computer through any type of network, including a local area network (LAN) or a wide area network (WAN), or the connection may be made to an external computer (for example, through the Internet using an Internet Service Provider). In some embodiments, electronic circuitry including, for example, programmable logic circuitry, field-programmable gate arrays (FPGA), or programmable logic arrays (PLA) may execute the computer readable program instructions by utilizing state information of the computer readable program instructions to personalize the electronic circuitry, in order to perform aspects of the present invention.

Aspects of the present invention are described herein with reference to flowchart illustrations and/or block diagrams of methods, apparatus (systems), and computer program products according to embodiments of the invention. It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer readable program instructions.

These computer readable program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks. These computer readable program instructions may also be stored in a computer readable storage medium that can direct a computer, a programmable data processing apparatus, and/or other devices to function in a particular manner, such that the computer readable storage medium having instructions stored therein comprises an article of manufacture including instructions which implement aspects of the function/act specified in the flowchart and/or block diagram block or blocks.

The computer readable program instructions may also be loaded onto a computer, other programmable data processing apparatus, or other device to cause a series of operational steps to be performed on the computer, other programmable apparatus or other device to produce a computer implemented process, such that the instructions which execute on the computer, other programmable apparatus, or other device implement the functions/acts specified in the flowchart and/or block diagram block or blocks.

The flowcharts and block diagrams in the Figures illustrate the architecture, functionality, and operation of possible implementations of systems, methods, and computer program products according to various embodiments of the present invention. In this regard, each block in the flowcharts may represent a module, segment, or portion of instructions, which comprises one or more executable instructions for implementing the specified logical function(s). In some alternative implementations, the functions noted in the block may occur out of the order noted in the figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. It will also be noted that each block of the flowchart illustrations, and combinations of blocks in the flowchart illustrations, can be implemented by special purpose hardware-based systems that perform the specified functions or acts or carry out combinations of special purpose hardware and computer instructions.

Referring now to FIG. **1**, a schematic of an example of a computing infrastructure is shown. Computing infrastructure **10** is only one example of a suitable computing infrastructure and is not intended to suggest any limitation as to the scope of use or functionality of embodiments of the invention described herein. Regardless, computing infrastructure **10** is capable of being implemented and/or performing any of the functionality set forth hereinabove.

In computing infrastructure **10** there is a computer system (or server) **12**, which is operational with numerous other general purpose or special purpose computing system environments or configurations. Examples of well-known computing systems, environments, and/or configurations that may be suitable for use with computer system **12** include, but are not limited to, personal computer systems, server computer systems, thin clients, thick clients, hand-held or laptop devices, multiprocessor systems, microprocessor-based systems, set top boxes, programmable consumer electronics, network PCs, minicomputer systems, mainframe computer systems, and distributed cloud computing environments that include any of the above systems or devices, and the like.

Computer system **12** may be described in the general context of computer system executable instructions, such as program modules, being executed by a computer system. Generally, program modules may include routines, programs, objects, components, logic, data structures, and so on that perform particular tasks or implement particular abstract data types. Computer system **12** may be practiced in distributed cloud computing environments where tasks are performed by remote processing devices that are linked through a communications network. In a distributed cloud computing environment, program modules may be located in both local and remote computer system storage media including memory storage devices.

As shown in FIG. **1**, computer system **12** in computing infrastructure **10** is shown in the form of a general-purpose computing device. The components of computer system **12** may include, but are not limited to, one or more processors or processing units (e.g., CPU) **16**, a system memory **28**, and a bus **18** that couples various system components including system memory **28** to processor **16**.

Bus **18** represents one or more of any of several types of bus structures, including a memory bus or memory controller, a peripheral bus, an accelerated graphics port, and a processor or local bus using any of a variety of bus architectures. By way of example, and not limitation, such architectures include Industry Standard Architecture (ISA) bus, Micro Channel Architecture (MCA) bus, Enhanced ISA (EISA) bus, Video Electronics Standards Association (VESA) local bus, and Peripheral Component Interconnects (PCI) bus.

Computer system **12** typically includes a variety of computer system readable media. Such media may be any available media that is accessible by computer system **12**, and it includes both volatile and non-volatile media, removable and non-removable media.

System memory **28** can include computer system readable media in the form of volatile memory, such as random access memory (RAM) **30** and/or cache memory **32**. Computer system **12** may further include other removable/non-removable, volatile/non-volatile computer system storage media. By way of example only, storage system **34** can be provided for reading from and writing to a nonremovable,

non-volatile magnetic media (not shown and typically called a "hard drive"). Although not shown, a magnetic disk drive for reading from and writing to a removable, non-volatile magnetic disk (e.g., a "floppy disk"), and an optical disk drive for reading from or writing to a removable, non-volatile optical disk such as a CD-ROM, DVD-ROM or other optical media can be provided. In such instances, each can be connected to bus **18** by one or more data media interfaces. As will be further depicted and described below, memory **28** may include at least one program product having a set (e.g., at least one) of program modules that are configured to carry out the functions of embodiments of the invention.

Program/utility **40**, having a set (at least one) of program modules **42**, may be stored in memory **28** by way of example, and not limitation, as well as an operating system, one or more application programs, other program modules, and program data. Each of the operating system, one or more application programs, other program modules, and program data or some combination thereof, may include an implementation of a networking environment. Program modules **42** generally carry out the functions and/or methodologies of embodiments of the invention as described herein.

Computer system **12** may also communicate with one or more external devices **14** such as a keyboard, a pointing device, a display **24**, etc.; one or more devices that enable a user to interact with computer system **12**; and/or any devices (e.g., network card, modem, etc.) that enable computer system **12** to communicate with one or more other computing devices. Such communication can occur via Input/Output (I/O) interfaces **22**. Still yet, computer system **12** can communicate with one or more networks such as a local area network (LAN), a general wide area network (WAN), and/or a public network (e.g., the Internet) via network adapter **20**. As depicted, network adapter **20** communicates with the other components of computer system **12** via bus **18**. It should be understood that although not shown, other hardware and/or software components could be used in conjunction with computer system **12**. Examples, include, but are not limited to: microcode, device drivers, redundant processing units, external disk drive arrays, RAID systems, tape drives, and data archival storage systems, etc.

FIG. **2** shows a block diagram of an exemplary system in accordance with aspects of the invention. In embodiments, the system includes a telephone device (e.g. telephone) **100**, a primary microphone **102**, an additional microphone **104**, a speaker **106**, and a camera **108**. The telephone **100** may be a computing device and may be implemented using the computer system **12** of FIG. **1** or another suitable computing device. For example, the telephone **100** may comprise a processing unit **16**, a memory **28**, and a display **24**. The memory **28** may store applications and/or program modules including a volume control module **110** that is executed by the processing unit **16** to perform one or more of the processes described herein.

The additional microphone **104** and camera **108** may be integrated with the telephone, or may be separate from the telephone **100** and transmit electrical signals to the telephone **100** via wired or wireless communication. There may be any desired number of additional microphones **104**, including one or more than one (i.e., plural). There may be any desired number of cameras **108**, including one or more than one (i.e., plural). In embodiments, the additional microphone **104** and the camera **108** are micro devices. For example, the additional microphone **104** may be a micro audio device.

The primary microphone **102** and the speaker **106** may be configured to receive and output audio (e.g., acoustic signals) of a telephone conversation in a conventional manner. For example, the primary microphone **102** may comprise an acoustic-to-electric transducer or sensor that converts sound into an electrical signal, and the speaker **106** may comprise a transducer that turns an electrical signal into sound waves. In this manner, the telephone **100** may be used to conduct a telephone conversation by receiving acoustic signals at the primary microphone **102**, converting the acoustic signals to electrical signals, transmitting the electrical signals to another telephone (e.g., via a telephone network), receiving other electrical signals from the other telephone, converting and outputting the other electrical signals as other acoustic signals at the speaker **106**. A level of electrical power driving the speaker **106** may be selectively adjusted to increase or decrease the volume of the speaker **106**.

According to aspects of the invention, when the telephone **100** is being used to conduct a telephone conversation, the volume control module **110** is configured to receive data from the additional microphone **104** and the camera **108** and automatically adjust the volume of the speaker **106** based on this data. The volume control module **110** may comprise a program module **42** as described with respect to FIG. **1**. The volume control module **110** may be programmed to provide functionality including: image processing to detect a person in a camera image; image processing to determine a distance to an object in a camera image; image processing to determine a mood of a person based on body language of the person in a camera image; and natural language processing (NLP) to detect sensitive and/or confidential subject matter in a conversation. Based on data received from the additional microphone **104** and the camera **108**, and by using the programmed functionality, the volume control module **110** may determine situations where the volume of the speaker **106** of the telephone **100** is automatically reduced.

In an aspect of the invention, when the telephone **100** is being used to conduct a telephone conversation, the volume control module **110** receives an electrical signal from the additional microphone **104** and analyzes the signal using NLP to determine when the subject matter being discussed in a telephone call is sensitive or confidential. NLP is a technique for breaking sentences down into something understood by a system. Deep parsing breaks a sentence down into noun phrases and verb phrases and then figures the prepositional phrase. The sentence is further broken down by part. NLP is used for enabling computers to derive meaning from natural language input stemming from any number of sources. An exemplary technique is a classification technique in which a machine reads and breaks down sentences to classify them or understand their meaning and even sentiment.

Lemmatization is another technique that can be applied. Lemmatization is the process of grouping together different inflected forms of a word in order that it can be analyzed as a single item. For example, "walking", "walks", "walked" all have a lemma of "walk". This will allow a better chance of accuracy in subject classification.

Ontology driven techniques (a model for describing the world that consists of a set of types properties and relationship types) could also be used for deep parse understanding. A triple is the functional decomposition of any sentence. The triple is composed of a subject, predicate, and object. The predicate is the main verb of the sentence, and the object is the direct object of that verb (the action recipient). The subject is verb agent, i.e., the one who carries out the action. By decomposing language into triples, one can better under-

stand how entities relate to each other and navigate through unstructured text (via a triple store).

In embodiments, when the volume control module **110** determines (using NLP) that the subject matter being discussed in a telephone call is sensitive or confidential, the volume control module **110** causes the telephone **100** to reduce the volume of the speaker **106**. For example, the volume control module **110** may provide a signal to the processing unit **16**, which signal causes the processing unit to adjust (e.g., reduce) the electrical power provided to the speaker **106** for the purpose of lowering the volume of the speaker **106**.

In an aspect of the invention, when the telephone **100** is being used to conduct a telephone conversation, the volume control module **110** receives an image from the camera **108** and analyzes the image to determine whether to automatically reduce the volume of the speaker **106**. In embodiments, images collected by the camera **108** may be used to determine when another person is within a predefined distance relative to the telephone **100**. For example, the volume control module **110** may use image processing to determine when a person is within the field of view of the camera **108**, and to determine a distance from the telephone **100** to the person within the field of view of the camera **108**. The telephone **100** may store data defining a threshold distance, and the volume control module **110** may compare the threshold distance to the determined distance to the person in the field of view of the camera **108**. In embodiments, when the determined distance to the person in the field of view of the camera **108** is less than the threshold distance (e.g., indicating that the person is sufficiently close to the telephone **100**), the volume control module **110** causes the telephone **100** to reduce the volume of the speaker **106**.

In another aspect of the invention, when the telephone **100** is being used to conduct a telephone conversation, the volume control module **110** receives a series of images from the camera **108** and analyzes the images to determine whether to automatically reduce the volume of the speaker **106**. In embodiments, images collected by the camera **108** may be used to determine a level of annoyance of another person in the vicinity of the telephone **100**. The level of annoyance may be determined from body language such as facial expressions. For example, the volume control module **110** may use image processing techniques, in particular facial recognition programming, to determine when a person within the field of view of the camera **108** has reached a level of annoyance, e.g., by analyzing images from the camera **108** to determine that the person's detected mood has changed from a first mood (e.g., happy, indifferent, etc.) to a second mood (e.g., anger, contempt, etc.). In embodiments, when the volume control module **110** determines that a person's level of annoyance has changed in this manner, the volume control module **110** causes the telephone **100** to reduce the volume of the speaker **106**.

In an aspect of the invention, when the telephone **100** is being used to conduct a telephone conversation, the volume control module **110** receives an electrical signal from the additional microphone **104** and analyzes a loudness of the speaker **106** relative to an ambient noise level. In embodiments, the additional microphone **104** detects a loudness of the speaker of the telephone **100** and separately detects an ambient loudness of the surroundings (e.g., other noise in the area around the telephone **100**). In embodiments, the volume control module **110** compares the detected loudness of the speaker **106** to the detected ambient loudness. The telephone **100** may store data defining a threshold value, e.g., as a percentage or an absolute value. In embodiments, when the detected loudness of the speaker **106** exceeds the detected ambient loudness by more than the threshold value, the volume control module **110** causes the telephone **100** to reduce the volume of the speaker **106**.

Still referring to FIG. **2**, the telephone **100** may also include a location system **120** that determines a location of the telephone. For example, the location system **120** may be part of a GPS. In an aspect of the invention, when the telephone **100** is being used to conduct a telephone conversation, the volume control module **110** receives data from the location system **120** and analyzes the data to determine whether to automatically reduce the volume of the speaker **106**. In embodiments, the telephone **100** stores or has access to a list of predefined quiets areas, which may correspond to, for example, libraries, office spaces, etc. The list of predefined quiet areas may include locations (e.g., coordinates) of each quiet area. The volume control module **110** may compare coordinates of the telephone **100** provided by the location system **120** to coordinates of the predefined quiets areas to determine whether the telephone **100** is located within a predefined quiet area. In embodiments, when the telephone is within a predefined quiet area, the volume control module **110** causes the telephone **100** to reduce the volume of the speaker **106**.

The telephone **100** in accordance with aspects of the invention may be adapted to permit a user to configure aspects of the automatic volume control described herein. In embodiments, the volume control module **110** permits a user to selectively activate and deactivate automatic volume reduction for each of factors (e.g., sensitive/confidential material, distance to another person, level of annoyance of another person, loudness relative to ambient sound levels, and telephone location relative to quiet areas) independent of the other factors. For example, the volume control module **110** may cause the display **24** to display a user interface (UI) by which a user of the telephone **100** may provide input to configure the volume control module **110**.

In additional embodiments, the volume control module **110** is adapted to permit the user to configure (e.g., via the UI) features such as: whether or not to provide an alert to the user when it is determined to reduce to the speaker volume; and the speed at which the telephone automatically reduces the volume. For example, the user may be permitted to select one of the following modes of operation: the telephone provides an alert to the user without automatically reducing volume; the telephone provides an alert to the user and then automatically reduces volume a number of seconds after the alert; the telephone automatically reduces volume without providing an alert to the user. In another example, the user may be permitted to select a period of time over which the volume reduction takes place, e.g., from zero seconds (an instantaneous reduction) to a non-zero number of seconds (a slower, fading reduction).

FIGS. **3**A, **3**B, **3**C, and **3**D show exemplary embodiments in accordance with aspects of the invention. FIG. **3**A shows a system in which the telephone **100'** comprises a mobile phone **210**, and in which the primary microphone **102**, the additional microphone **104**, the speaker **106**, and the camera **108** are integrated with the mobile phone **210**. The mobile phone **210** may be a smartphone comprising a processing unit, a memory, and a display **24**. The memory may store mobile applications and/or program modules including the volume control module **110** that is executed by the processing unit. The display **24** may comprise a capacitive touch screen display that outputs an electronic visual display and that receives user input via stylus and/or finger touch. The mobile phone **210** may also include at least one antenna

configured for wireless communication via at least one of cellular, WiFi, Bluetooth, and near field communication (NFC). The mobile phone **210** may also include a rechargeable battery and sensors such as an accelerometer, gyroscope, compass, and GPS.

FIG. **3**B shows a system in which the telephone **100"** comprises a mobile phone **220**, and in which the additional microphone **104**, the speaker **106**, and the camera **108** are separate from the mobile phone **210**. The mobile phone **220** may be a smartphone comprising a processing unit, a memory, and a display **24**. The memory may store mobile applications and/or program modules including the volume control module **110** that is executed by the processing unit. The display **24** may comprise a capacitive touch screen display that outputs an electronic visual display and that receives user input via stylus and/or finger touch. The mobile phone **220** may also include at least one antenna configured for wireless communication via at least one of cellular, WiFi, Bluetooth, and near field communication (NFC). The mobile phone **220** may also include a rechargeable battery and sensors such as an accelerometer, gyroscope, compass, and GPS. In the embodiment shown in FIG. **3**B, the additional microphone **104**, the speaker **106**, and the camera **108** are integrated in a headset or earphones **222** worn by the person using the mobile phone **220**. The headset or earphones **222** may communicate with the mobile phone **220** by wired or wireless communication.

FIG. **3**C shows a system in which the telephone **100'"** comprises a landline telephone **230**, and in which the primary microphone **102**, the additional microphone **104**, the speaker **106**, and the camera **108** are integrated with the landline telephone **230**. The landline telephone **230** may comprise a handset **231**, a display **24**, and buttons **232**. Additionally, the landline telephone **230** may comprise the processing unit and memory that stores the volume control module **110**.

FIG. **3**D shows a system in which the telephone **100'"'** comprises a landline telephone **240**, and in which the additional microphone **104** and the camera **108** are separate from the landline telephone **240**. The landline telephone **240** may comprise a handset **231**, a display **24**, and buttons **232**. Additionally, the landline telephone **240** may comprise the processing unit and memory that stores the volume control module **110**. The additional microphone **104** may comprise plural additional microphones **104** arranged at locations around the landline telephone **240**, e.g., at locations in an office space. The camera **108** may comprise plural cameras **108** arranged at locations around the landline telephone **240**, e.g., at locations in an office space.

FIG. **4** shows a flowchart of a method in accordance with aspects of the invention. Steps of the method of FIG. **4** may be performed in the environment illustrated in FIGS. **2** and **3**A-D, and are described with reference to elements shown in FIGS. **2** and **3**A-D.

FIG. **4** depicts a method of automatically adjusting speaker volume of a telephone. At step **401**, a telephone (e.g., telephone **100**) receives user input defining configuration of automatic volume control functionality for the telephone. In embodiments, the telephone displays a user interface (UI) to a user, and receives input from the user via the UI, wherein the input defines configurable parameters associated with a volume control module (e.g., volume control module **110**) of the telephone.

At step **402**, the telephone detects that a telephone conversation is occurring. The telephone may use conventional processes to detect when it is being employed to conduct a telephone conversation.

At step **403**, the telephone receives data from a camera. In embodiments, the telephone receives at least one image from a camera (e.g., camera **108**). As described with respect to FIGS. **2** and **3**A-**3**D, the camera may be integrated with the telephone or separate from the telephone.

At step **404**, the telephone analyzes the data from the camera (from step **403**). In embodiments, the volume control module of the telephone uses at least one camera image to determine whether another person is within a predefined distance relative to the telephone, e.g., in the manner described with respect to FIG. **2**. In additional embodiments, the volume control module uses camera images to determine an annoyance level of another person, e.g., in the manner described with respect to FIG. **2**.

At step **405**, based on the analysis at step **404**, the telephone automatically adjusts the volume of a speaker (e.g., speaker **106**) of the telephone. Step **405** may be performed in a manner similar to that described with respect to FIG. **2**. In the event the user provided configuration input (e.g., at step **401**), then the adjusting the volume of the speaker at step **405** may be performed in accordance with the user-defined configuration. For example, the phone may be configured to provide an alert to the user (e.g., a display and/or vibration) prior to automatically adjusting the volume of the speaker.

At step **406**, the telephone receives location data from a location system. In embodiments, the telephone includes a GPS sensor that provides location data to the volume control module. The location data may define a GPS location of the telephone.

At step **407**, the telephone analyzes the location data from step **406**. In embodiments, the volume control module of the telephone compares the location data to predefined quiet areas, e.g., in the manner described with respect to FIG. **2**. Step **406** may include the telephone accessing the list of quiet places in memory of the telephone, accessing another computing device to obtain the list of quiet areas, or submitting the location data of the telephone to a service provider that returns an indication of whether the telephone location coincides with a predefined quiet area.

At step **408**, based on the analysis at step **407**, the telephone automatically adjusts the volume of the speaker of the telephone. Step **408** may be performed in a manner similar to step **405**.

At step **409**, the telephone receives audio signal data from a microphone (e.g., additional microphone **104**). As described with respect to FIGS. **2** and **3**A-**3**D, the microphone may be integrated with the telephone or separate from the telephone.

At step **410**, the telephone analyzes the data from the microphone (from step **409**). In embodiments, the volume control module uses the data from the microphone to compare the loudness of the speaker to the ambient loudness, e.g., in the manner described with respect to FIG. **2**. In additional embodiments, the volume control module uses the data from the microphone determine whether the telephone conversation includes sensitive or confidential words, e.g., using NLP in the manner described with respect to FIG. **2**.

At step **411**, based on the analysis at step **410**, the telephone automatically adjusts the volume of the speaker of the telephone. Step **408** may be performed in a manner similar to step **405**.

Each of steps **405**, **408**, and **411** may include an additional step of comparing a current volume level of the speaker to a minimum volume level. In the even the volume of the speaker is already at a minimum level, the volume control

module may be programmed not automatically further reduce the volume of the speaker, since doing so might make the conversation imperceptible to the user.

In embodiments, a service provider, such as a Solution Integrator, could offer to perform the processes described herein. In this case, the service provider can create, maintain, deploy, support, etc., the computer infrastructure that performs the process steps of the invention for one or more customers. These customers may be, for example, any business that uses technology. In return, the service provider can receive payment from the customer(s) under a subscription and/or fee agreement and/or the service provider can receive payment from the sale of advertising content to one or more third parties.

In still additional embodiments, the invention provides a computer-implemented method for performing one or more of the processes described herein. In this case, a computer infrastructure, such as computer system **12** (FIG. **1**), can be provided and one or more systems for performing the processes of the invention can be obtained (e.g., created, purchased, used, modified, etc.) and deployed to the computer infrastructure. To this extent, the deployment of a system can comprise one or more of: (1) installing program code on a computing device, such as computer system **12** (as shown in FIG. **1**), from a computer-readable medium; (2) adding one or more computing devices to the computer infrastructure; and (3) incorporating and/or modifying one or more existing systems of the computer infrastructure to enable the computer infrastructure to perform the processes of the invention.

The descriptions of the various embodiments of the present invention have been presented for purposes of illustration, but are not intended to be exhaustive or limited to the embodiments disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the described embodiments. The terminology used herein was chosen to best explain the principles of the embodiments, the practical application or technical improvement over technologies found in the marketplace, or to enable others of ordinary skill in the art to understand the embodiments disclosed herein.

What is claimed is:

**1**. A computer implemented method, comprising:

displaying, by a telephone, a user interface (UI), wherein the telephone comprises a memory, a display, a processing unit running a volume control module, a primary microphone integrated with the telephone, an additional microphone integrated with the telephone, and a speaker integrated with the telephone;

receiving, by the telephone, input from a user via the UI, wherein the input defines at least one user-configurable parameter of the volume control module;

detecting, by the telephone, that the telephone is being used for a conversation;

receiving, by the volume control module, data from the additional microphone;

analyzing, by the volume control module, the data using natural language processing to determine usage of sensitive or confidential words in the conversation; and

automatically adjusting a volume of the speaker of the telephone during the conversation based on the determining usage of sensitive or confidential words in the conversation, wherein the automatically adjusting comprises the volume control module causing the processing unit to reduce electrical power provided to the speaker to lower the volume of the speaker.

**2**. The method of claim **1**, further comprising:

detecting, by the additional microphone, a conversation loudness of the speaker of the telephone;

detecting, by the additional microphone, an ambient loudness of an area around the telephone;

determining that the detected conversation loudness exceeds the detected ambient loudness by more than a predefined threshold value; and

automatically lowering the volume of the speaker based on the determining that the detected conversation loudness exceeds the detected ambient loudness by more than the predefined threshold value.

**3**. The method of claim **1**, further comprising:

receiving image data from a camera integrated with the telephone;

analyzing, using image processing, the image data from the camera to determine a distance of the telephone to another person; and

automatically lowering the volume of the speaker based on the determining the distance of the telephone to another person is less than a predefined threshold distance.

**4**. The method of claim **1**, further comprising:

receiving plural images from a camera integrated with the telephone;

analyzing the plural images from the camera to determine a detected level of annoyance of another person based on body language; and

automatically lowering the volume of the speaker based on the determining the detected level of annoyance of another person.

**5**. The method of claim **4**, wherein the level of annoyance is determined from facial expressions using facial recognition programming and comprises analyzing images from the camera to determine that a detected mood has changed from a first mood to a second mood.

**6**. The method of claim **1**, further comprising providing an alert to a user of the telephone after the analyzing and before the automatically adjusting the volume of the speaker.

**7**. The method of claim **1**, wherein a service provider at least one of creates, maintains, deploys and supports the telephone.

**8**. The method of claim **1**, wherein steps of claim **1** are provided by a service provider on a subscription, advertising, and/or fee basis.

**9**. The method of claim **1**, wherein during the conversation the telephone receives acoustic signals at the primary microphone, converts the acoustic signals to electrical signals, transmits the electrical signals to another telephone, receives other electrical signals from the other telephone, and converts and outputs the other electrical signals as other acoustic signals at the speaker.

**10**. A system for automatically adjusting telephonic conversation volume, comprising:

a telephone comprising: a memory, a display configured to display a user interface (UI) and receive user input via the UI, a processing unit running a volume control module, a primary microphone integrated with the telephone, and a speaker integrated with the telephone;

at least one additional microphone that is separate from the telephone and that communicates via wired or wireless communication with the telephone to provide microphone data to the volume control module; and

at least one camera that is separate from the telephone and that communicates via wired or wireless communication with the telephone to provide camera data to the volume control module;

wherein the volume control module is configured to automatically reduce a volume of the speaker of the telephone during a conversation based on at least one of:

determining usage of sensitive or confidential words in the conversation by analyzing the microphone data using natural language processing; and

determining a detected level of annoyance of another person by analyzing plural images from the at least one camera.

**11**. The system of claim **10**, wherein the volume control module is configured to automatically reduce the volume of the speaker of the telephone during the conversation based on determining a distance of the telephone to another person is less than a predefined threshold distance, wherein the distance is determined by analyzing the camera data.

**12**. The system of claim **10**, wherein the volume control module is configured to automatically reduce the volume of the speaker of the telephone during the conversation based on determining that a location of the telephone coincides with a predefined quiet area.

**13**. The system of claim **10**, the volume control module is configured to cause the telephone to provide an alert to the user and then perform the automatically reducing the volume of the speaker a predefined time after the alert.

**14**. The system of claim **10**, the volume control module is configured to permit the user to select, via the UI, a period of time over which the automatically reducing the volume of the speaker takes place.

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